DOCUMENT RESUME

ED 042 803 TM 000 074

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TITLE	An Investigation of the Relationship of Intellective and Personality Variables to Success in an Independent Study Science Course Through the Use of a Modified Multiple Regression Model.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
PUB DATE	Mar 70
NOTE	7p.; Paper presented at the annual meeting of the National Council of Measurement in Education, Minneapolis, Minnesota, March, 1970
EDRS PRICE	EDRS Price MF-$0.25 HC-$0.45
DESCRIPTORS	Academic Achievement, Biological Sciences, *College Science, *College Students, Grade Prediction, *Independent Study, Individual Characteristics, Multiple Regression Analysis, *Personality, Predictive Ability (Testing), *Predictor Variables, Rating Scales
IDENTIFIERS	*Audio Tutorial System, CEEB, College Entrance Examination Board, Guilford Zimmerman Temperament Survey, SAT, Scholastic Aptitude Test

ABSTRACT

This is an empirical study of selected learner characteristics and their relation to academic success, as indicated by course grades, in a structured independent study learning program. This program, called the Audio-Tutorial System, was utilized in an undergraduate college course in the biological sciences. By use of multiple regression analysis, the most stable predictors were found to be the Restraint scale of the Guilford-Zimmerman Temperament Survey, high school rank, SAT-Verbal, CEEB-Mathematics, and high school social studies grade. Limitations on the study include the fact that it was correlational and not experimental and that its sample consisted of volunteers who completed the course. (DG)

ED042803

AN INVESTIGATION OF THE RELATIONSHIP OF INTELLECTIVE AND PERSONALITY VARIABLES TO SUCCESS IN AN INDEPENDENT STUDY SCIENCE COURSE THROUGH THE USE OF A MODIFIED MULTIPLE REGRESSION MODEL[1]

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OBJECTIVES

The objectives of this study were: (1) to assess the relative contributions of selected individual learner characteristics to the prediction of academic success in a structured independent study learning system; and (2) to predict achievement for individual students in the independent study course.

RATIONALE

A learning program which attempts to implement a program of individualized instruction must be adjustable to a wide range of individual differences (IDs) which are related to student achievement. The acquisition of empirical knowledge about IDs and their relation to various criteria of learning (e.g., academic success in terms of grades, test performance, etc.) is a necessary prelude to such adjustments. Lack of empirical knowledge about IDs may be attributable to a variety of factors. One factor which is theoretically relevant is the large number of intellective variables and their interactions (dependencies) in a learning situation. Insight into this problem certainly calls for multivariate analysis methods and a correspondingly large sample.

The foregoing reasoning suggests the use of a multiple regression analysis model, in which numerical coefficients (beta weights) are assigned to the predictor

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[1]A paper presented at the annual convention of the National Council of Measurement in Education, Minneapolis, March, 1970.

[2]This study was supported in part by a grant from the U.S. Office of Education and was the first author's thesis research for a Ph.D. degree from Purdue University 1969.

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variables so that the weighed sum of these term s correlates maximally with the criterion variable. Interactions between predictors may be assessed with a method analogous to analysis of variance by including the cross-products of predictors in the regression equation as new predictor variables. If an interaction term used in this fashion receives a nonzero beta weight, the beta weights of the other predictors will change. This latter phenomenon can be avoided by analyzing the predictor and criterion variables in standard score form. Hence the model used in this research has the form

$$Z_1 = B_2 Z_2 + B_3 Z_3 + B_4 (Z_2 Z_3) + A.$$

The relative contribution of each independent variable (and cross-product) to the prediction of the criterion variance may be tested for significance with a t-test.

The focus of this research was the empirical study of selected learner characteristics and their relation to academic success in a structured independent study learning program. This program represents a unique approach to the individualization of instruction in science at the undergraduate level and is called the Audio-Tutorial System. It features independently scheduled but structured laboratory and learning sessions, audio-tape tutorial presentations, emphasis upon personal student-instructor contact, and periodic oral and written quizzes. Developed by Postlethwait, Novak, and Murray (1969) the Audio-Tutorial System represents an approach to individualized instruction within a large class setting and features provision for self-pacing and student controlled repetition of learning experiences.

A battery of intellective learner characteristics (i.e., those characteristics which represent observable products of cognitive processes) and personality characteristics were utilized in this study. They were selected on the basis of theoretical relevance to the learning criterion and the instructional setting. It

seems likely that personality characteristics would assume a more important rer role in an independent study course than they have in the past in relation to student performance and achievement in traditionally organized courses.

METHOD

College freshmen and sophomores (N=630) who voluntarily completed the necessary data forms and were enrolled in a one-semester, introductory, biological science course taught in the independent study mode at a large midwestern university comprised the treatment sample in this study. The sample was divided into two equal groups for purposes of validation and cross-validation analyses.

The variables used were: (1) from the personality area, scores on the Guilford-Zimmerman Temperament Survey; and, (2) secondary school counsellor ratings of achievement-oriented personality ratings; and (3) from the intellective area, high school grades in science, mathematics, social studies, and English; high school graduation rank; and CEEB and SAT scores. The criterion of final course grade was converted numerically using the scale A=6, B=5, etc.

Data were correlated using a build-up linear multiple regression analysis model modified as noted earlier in order to permit the estimation of the relative importance of individual learner characteristics to the prediction of the criterion variance. To reduce the number of variables to a meaningfully manageable smaller number, all variables (with no interaction terms) were correlated in the regression analysis statistical program. The variables contributing significantly to the prediction of the criterion ($p < .10$) along with the cross products of the significant intellective and personality predictors were entered into the regression program a second time (second stage analysis). Also entered at this time were the cross-product scores of each intellective predictor and each personality predictor. The results were cross-validated on an appropriate sample.

RESULTS

The following predictors, when combined in the modified multiple regression model used, made a significant contribution ($p < .05$) to the prediction of the achievement criterion. The restraint and ascendance scales of the Guilford-Zimmerman Temperament Survey; high school graduation rank; SAT-Verbal; CEEB Mathematics; counsellor rating 5 (critical and questioning attitude of the student); social studies high school grade; and the cross-product of the restraint scale and English high school grade. These variables from the multiple regression analysis are presented in the first column of Table 1. The regression coefficients (B) and

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Insert Table 1 about here

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their standard errors (SeB) are tabulated in columns two and three. Column four lists the t-ratios for the test of significance of each predictor in the battery. The percentages of criterion variance attributable to each variable in the equation are listed in column five. The zero-order correlation coefficients between the variables and the criterion are tabulated in column six. Columns seven through 13 list the zero-order correlation coefficients among the predictor variables. The multiple correlation between these predictors and the criterion is .63 and indicates that 40 percent of the criterion variance is attributable to these predictors.

Summing the percentages of criterion variance for the intellective predictors (variables 3, 4, 5, and 7) from column five yields a figure of 30.85 percent. The interaction term (variable 8) accounts for only 0.76 percent and the remaining personality variables account for 8.62 percent. Thus the intellective predictors accounted for approximately 75 percent (30/40) of the predicted criterion variance and the personality predictors accounted for less than 25 percent (8.6/40).

Of the 25 interaction terms entered into the second stage analysis, only the restraint x English grade interaction yielded a significant regression coefficient. Although this interaction is statistically significant, its practical significance is very low.

The results were cross-valid by entering the eight variables in Table 1 into a regression analysis program using the cross-validation sample. The application of the t-test revealed that variables 2, 6, and 8 (ascendance, councellor rating 5, and restraint x English grade) did not contribute significantly to the multiple correlation. Hence the stable predictors were restraint, high school rank, SAT-Verbal, CEEB-Mathematics, and high school social studies grade.

DISCUSSION

The finding that the intellective predictors made the greatest contribution to the prediction of academic success is consistent with findings of other predicti studies. The achievement-oriented personality characteristics, which were ratings by guidance counsellors from each subject's high school and the interactions terms between intellective and personality variable demonstrated little value in this prediction study.

Of the ten personality traits measured by the GZTS, the restraint scale alone remained a stable predictor even in the presence of the more powerful intellective predictors.

The results of this study and inferences made from it should be interpreted carefully for at least two reasons. First, the design was correlational not experimental. Thus, cause and effect cannot be specified. Second, subjects who did not voluntarily complete the data forms or dropped the course (11 percent) were exclud from the sample. Thus, there could be selective bias in the samples.

Within these limitations, it appears that successful performance in an independent study biological science laboratory system is correlated with restraint (i.e, the capacity to be serious minded and responsible), verbal aptitude, achievement in mathematics and social studies, and overall high school rank.

This study has identified intellective and personality characteristics which may be useful for predicting achievement levels in specifiable learning situations Using this information it might be possible to offer instructional alternatives,

to predict in which one a student would achieve best, and to make the alternatives available to the student. Secondly, the prediction system identifies personal characteristics of the student in which he is weak or strong. Such information could be used to provide remedial counselling or instruction or to adapt the instruction to fit the strength or weakness.

Of course, all the potential uses of prediction require much further investigation as does the prediction system itself. With multiple Rs as high as .63 we are accounting for only 40 percent of the criterion variance. Hopefully other and better predictors can be found. On the other hand, it could be argued that the percentage of criterion variance accounted for by the battery is low because of measurement error. While the predictors used in this study did not represent a broad sampling of different types of predictors, the results seem to give weight to the latter interpretation: limitation due to error.

Hopefully, with a broader sampling of pertinent predictors, better control of measurement procedures, and new instructional systems which facilitate provision for individual differences, substantial increases in student achievement can be attained

TABLE 1
SIGNIFICANT PREDICTORS OF FINAL COURSE GRADE IN
A-T BIOLOGY, SECOND STAGE PREDICTORS (N=315)

1	2	3	4	5	6	7	8	9	10	11	12	13
Variable	B	SeB	t[1]	Bry	Ry	2	3	4	5	6	7	8
1. Restraint	.17	.05	3.8**	4.19	.25**	00	13*	09	11	04	13*	09
2. Ascendance	-.12	.05	-2.7**	1.42	-.12*		-03	06	-05	06	-03	-05
3. H S Rank	-.18	.07	2.7**	9.03	.51**			48**	41**	39**	63**	04
4. SAT-Verbal	.16	.05	3.1**	6.67	.41**				38**	21**	38**	00
5. CEEB-Math	.19	.05	3.6**	7.29	39**					23**	18**	06
6. Rating 5	.10	.05	2.2*	3.01	.29**						22**	01
7. Social Studies Grade	.18	.06	3.1**	7.86	.44**							-03
8. Restraint x English Grade	-.10	.04	-2.2*	.76	-.08							
Total Predicted Criterion Variance				40.23%								
Multiple Correlation	.63**											

[1]Two-tailed test

* $p < .05$

** $p < .01$